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Changes in Intraocular Pressure While Using Electronic Devices in Sitting and Supine Positions

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Abstract:

Objective: This study aimed to compare intraocular pressure (IOP) measurements in sitting and supine positions while exposed to electronic devices.

Material and Methods: A total of 26 participants (52 eyes) had their IOP measured by Keeler Pulairs tonometer in sitting and supine positions both before and after using a mobile phone. The IOP was initially measured while sitting, followed by 2 minutes in a supine position. The IOP was then measured again after watching the movie for 30 minutes in each position under daylight conditions. Postural IOP changes due to exposure to electronic devices were measured and compared.

Results: The IOP exhibited a statistically significant increase (p-value<0.05) in the supine position compared to the sitting position, both before and after exposure to the electronic device. Following a 30-minute period of exposure, the IOP was significantly reduced by 0.7 mmHg in the sitting position (from 12.7 mmHg to 12.0 mmHg, p-value<0.05). However, there were no significant differences observed in the supine position (13.3 mmHg versus 13.3 mmHg, p-value>0.05).

Conclusion: Different postural positions have an effect on IOP, as IOP is higher in the supine position than in the seated position. There was a decline in the IOP after 30 minutes of exposure in the sitting position. However, there are no changes in IOP that occur in the supine position. These findings suggest a potential link between mobile phone usage and postural changes in IOP, which could have implications for ocular health in individuals who frequently use mobile devices.

Keywords: electronic devices, intraocular pressure, sitting, supine

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Introduction

Nowadays, the advances of electronic devices have become a huge part of our daily activities. It can be in the form of a tablet, mobile phone, computer, laptop, and others. Most of its features are not only for making calls but also for entertainment purposes such as Instagram, watching movies, and checking email. In Malaysia, the number of people who have access to mobile phones has increased from 98.6% to 99.6%[1]. Within a day, most people spend a great amount of time using their mobile phones rather than socially engaging with people. This prolonged session with electronic devices will produce eyestrain and eventually cause a negative effect on intraocular pressure.

Intraocular pressure (IOP) is actually the fluid pressure inside the eye and is usually measured by an instrument known as tonometer. According to research, electronic device users normally experience the symptoms of eyestrain and blurred vision known as Computer Vision Syndrome (CVS)[2]. This CVS happens due to the eye need to accommodate more for a prolonged period of time to see the visual task on the mobile phone. There is a correlation between accommodation and the IOP, as accommodation could lead to a short IOP elevation in progressing myope[3]. A previous study reported that there was elevated IOP in an individual who worked on the computer screen after a 4-hour session, while exposure between 1 and 6 hours of computer use does affect IOP in young adults[4].

The aspects of mobile phones related to conventional computers, such as resolution, brightness, screen sizes, and light conditions, do fluctuate the IOP. In the low-light condition, the changes in IOP were faster and significantly increased, especially when reading or writing on the mobile phone.5 This is due to the increased pupil diameter in darkness, which causes more visual fatigue and leads to elevated IOP[5].

Higher elevated IOP is known as a risk factor for glaucoma, and it is usually clinically measured in a sitting position. Postural changes do have a significant effect on IOP, with IOP in the supine position being greater than in the sitting position[6]. The IOP has also been shown to rise by as much as 6 mmHg when lying down in both normal subjects and glaucoma patients. The changes in the IOP associated with the position can occur in a short time. It was shown that within 1-2 minutes after working on different yoga exercises with a head-down posture, there are slight increases in the IOP[7]. The changes in IOP have also been proven to occur within 15 minutes of sitting and supine position using air puff tonometry[6]. The non-contact nature of air puff tonometry makes it a better choice for population-based studies than Goldman Applanation Tonometry (GAT) because it can measure changes in IOP even when the person is in different positions[8].

In addition, the supine position is an important contributor to the IOP elevation observed at night, which is associated with the progression of open-angle glaucoma[9]. Neck flexion is also a contributor and especially occurs within electronic devices, such as mobile phone[10]. The risk of slowly increasing IOP will gradually damage the optic nerve. It will cause compression on the retinal artery, thus leading to optic neuropathy. This increased pressure causes concern among electronic device users who have longer exposure times. Hence, this study was done to investigate the effect of the electronic devices on IOP changes in sitting and supine positions by using a Keeler Pulsair non-contact tonometer.

Material and Methods

Study design

The study design for this research is an experimental cross-sectional study design. This experimental study was conducted in the paediatric room of UiTM Vision Care (UiVC), UiTM Puncak Alam campus. The research tool that is being used for measuring IOP is the Keeler Pulsairs tonometer.

Study participants

The study was conducted on the 52 eyes of 26 healthy individuals aged between 15 and 35 who were patients at the UiVC clinic. The participants were chosen based on a thorough eye examination that involved history assessment, visual acuity measurement with the Snellen chart, binocular evaluation (near point of accommodation, near point of convergence, and cover test), subjective refraction, slit lamp examination, and fundus assessment. Eligible participants were those with best corrected visual acuity of 6/6 or better, normal binocular vision status, good general health, and good ocular health. Participants with a history of ocular disease such as glaucoma, any significant eye injuries, or any binocular problem such as strabismus, amblyopia, and on the medication of steroids were excluded from this study.

The ethical committee of Universiti Teknologi MARA (600-IRMI (5/16) REC/24/19) approved this study, and it complied with the Declaration of Helsinki's guidelines for the use of human subjects in scientific research. The study purpose and the methodology was explained to the participants and informed consents were obtained from the participants before the study commenced.

IOP measurement

The procedure was done in the morning (8-10 am) to avoid the diurnal changes of IOP. A Lenovo Tab 7 Essential mobile phone, featuring a 7.0-inch screen with a resolution of 600x1,024 pixels and a brightness of 300 nits, served as the electronic device for this study. Participants were instructed to focus on the movie being played on the mobile phone and maintain a consistent posture and distance throughout its use.

Initially, the participant was seated, and a Keeler Pulsairs non-contact tonometer was used to measure their IOP. The participant was then asked to lie down on their back in the supine position for 2 minutes, and the IOP was measured again using the same instrument. A 2-minute rest period was provided to allow IOP to return to baseline levels before switching positions. This duration was selected based on prior studies indicating that a short rest period is sufficient for IOP stabilization in similar contexts[7]. These initial measurements in sitting and supine positions were recorded as baseline measures of IOP.

Next, the participant is exposed to the mobile phone in a sitting position at a habitual distance (40 cm) for 30 minutes (watching a movie), and the IOP measurement is taken. Another 2 minutes of resting is given to the participant to reestablish their IOP to the baseline level before being exposed to the mobile phone in the supine position. The similar step of watching a movie in a sitting position is repeated in a supine position at a distance of 20 cm from the mobile phone. Three measurements of IOP were performed repeatedly in each position, and the average IOP value was recorded.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 21. Results from the study were tested for normality using the Shapiro-Wilk test. The Wilcoxon signed-rank test was used to make a comparison of the changes in the IOP between postural positions before and after exposure to electronic devices. The p value of the two-sided test was considered statistically significant when it was less than 0.05.

Results

A total of 52 eyes (26 participants) with a mean age of 22.65±1.56 years were examined and recruited for the study. Table 1 shows the characteristics of the participants in this research study. Meanwhile, Table 2 illustrates the contrasts in IOP findings between the sitting positions before and after exposure. The median IOP values before exposure in the sitting position (12.70 mmHg) were significantly higher (p-value<0.05) than those observed after a 30-minute exposure (12.00 mmHg).

Table 1 Demographic data of the participants

Participants	Mean±S.D.
Age (years)	22.65±1.56
Refractive error, SER (D)	-1.58±1.07

SER=spherical equivalent, S.D.=standard deviation, D=diopter

Table 2 Intraocular Pressure (IOP) measurement in sitting position

IOP measurement	Median (IQR)
Before exposure (mmHg)	12.70 (3.6)
After exposure (mmHg)	12.00 (2.3)
Z statistic	-2.50
P	<0.05*

SER=spherical equivalent, S.D=standard deviation,
IQR=interquartile range, mmHg=millimeter of mercury
*Statistically significant

Table 3 displays the IOP findings in the supine position before and after exposure. The median IOP in the supine position remained consistent at 13.3 mmHg. The IOP values ranged from 10 to 18.7 mmHg before exposure in the supine position and from 9.3 to 27 mmHg following exposure. No statistically significant variations in IOP were observed in the supine position before and after exposure (p-value>0.05).

Table 3 Intraocular Pressure (IOP) measurement in supine position

IOP measurement	Median (IQR)
Before exposure (mmHg)	13.30 (3.0)
After exposure (mmHg)	13.30 (3.0)
Z statistic	-2.42
P	>0.05

IQR=interquartile range, mmHg=millimeter of mercury

The initial IOP in the supine position was significantly higher than that in the sitting position by 0.6 mmHg (p-value=0.012). Following 30 minutes of exposure to electronic devices, the IOP increased significantly by 1.3 mmHg from sitting to supine position (p-value=0.002). The median IOP decreased by about 0.7 mmHg after 30 minutes of exposure in the sitting position, while no changes occurred in the supine position.

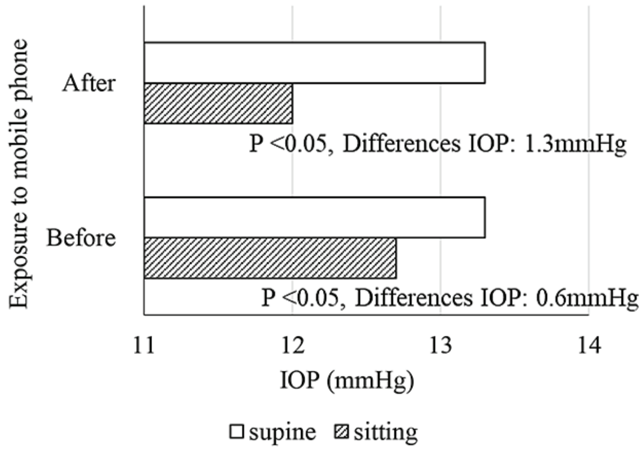
The overall changes of IOP values in sitting and supine positions following exposure to electronic device was shown in Figure 1.

Discussion

The present study demonstrated that postural posture can cause a temporary increase in IOP, as the IOP in the supine position was higher than that in the sitting position. This might happen due to the fact that in the supine position, a higher gravitational force causes a redistribution of body fluids, resulting in choroidal vascular engorgement and also an increase in the episcleral venous pressure[11,12].

Previous studies had confirmed that IOP increased by up to 6.0 mmHg when transitioning from a seated to a supine position[13]. The IOP in eyes with glaucoma was also seen to be 3–4 mmHg greater when the eyes were in a supine position compared to when they were sitting[14]. These trends are consistent even among individuals with normal tension glaucoma[15]. Elevated IOP has been linked to more extensive visual field loss and accelerated visual deterioration[16].

Notably, alterations in IOP can manifest swiftly with changes in posture. A study examining various yoga exercises involving head-down positions demonstrated changes in IOP findings within 1 or 2 minutes following posture changes, with levels reverting to baseline after 2 minutes in the initial position[7]. Similarly, our study observed an increase in IOP values after 2 minutes in the supine position (12.00 mmHg) than in the sitting position before (12.70 mmHg).



IOP=Intraocular pressure

Figure 1 IOP changes in sitting and supine position following exposure to an electronic device

According to reports, prolonged exposure to computer screens for a duration of 4 hours led to an increase in IOP[17]. However, our study yielded contrasting results, demonstrating a decrease in IOP after just 30 minutes of mobile phone exposure while seated. We believed that this phenomenon could be attributed to near-work accommodations. A study conducted in Poland that investigated the impact of work durations on visual functions found a significant decline in accommodation[18]. It's been suggested that such accommodation-related changes, which lead to decreased IOP, may be linked to the mechanical effects of the ciliary muscle and corneal surface. Research by Pas-Wyrošlak et al.[19] indicated that the corneal surface temperature increases during near work with a display screen at a short distance, accompanied by a reduction in IOP. Additionally, near-work accommodation prompts contraction of the ciliary muscle, enlarging the pores in the trabecular meshwork and enhancing aqueous humour outflow[19]. These findings are particularly beneficial for glaucoma patients, as evidenced by reduced IOP after just 10 minutes of reading compared to gazing fixedly into the distance[20].

Interestingly, our study observed no changes in IOP in the supine position during mobile phone exposure, likely due to limitations in patient concentration stemming from physiological stress. This stress triggers sympathetic input, impacting IOP through changes in norepinephrine levels[21]. Consistent concentration on tasks, acting as a sympathetic stimulus, may elevate IOP values. Therefore, it may be preferable to engage in alternative near-work activities, such as games, to mitigate such effects.

After mobile phone exposure, IOP levels differed by 1.3 mmHg between sitting and supine positions. As with initial IOP values before mobile phone exposure, greater IOP values were found in the supine position. The involvement of neck flexion during the use of electronic devices may contribute to IOP variations between the two positions.10 It was shown that utilizing a mobile phone while sitting resulted in a considerably higher head flexion angle than when standing[22]. Apart from that, the working distance when using a mobile phone may have an impact on accommodation and, indirectly, IOP values. The close distances when looking at a mobile phone will cause increased demands on accommodation and vergence, especially in prolonged periods of time, which could exacerbate the symptoms of CVS[23]. The viewing distance in the supine position was shorter than that in the sitting position[24]. This was similar to the distance in this procedure, which is 20 cm for supine and 40 cm for sitting. To maintain a clear image, the eyes need to focus, causing sustained active accommodation and convergence, which lead to elevated IOP. Other factors that could contribute to IOP changes, such as screen brightness and the instrumentation used to measure IOP, were not considered in our study because they were controlled.

Conclusion

There was a statistically significant increase in IOP values from the sitting position to the supine position. However, after 30 minutes of using an electronic device in sitting position, the IOP value decreased. The supine position did not exhibit the same changes, with the IOP level remaining constant both before and after exposure to electronic devices. In conclusion, while mobile phone usage appears to influence IOP, particularly in the supine position, these results are preliminary and should be interpreted with caution, given the study's small sample size. Further research with larger sample sizes and more diverse populations is needed to confirm these results before making definitive recommendations.

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Conflict of interest

The authors have no conflicts of interest to declare.

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